



Variant muscle fibers connecting the orbicularis oculi to the orbicularis oris: case report

Norio Kitagawa^{1,2,*}, Joe Iwanaga^{2,3,4,5,6,*}, R.Shane Tubbs^{3,4,7,8,9}, Hongtae Kim¹⁰, Yong-Suk Moon¹⁰, Mi-Sun Hur¹⁰

¹Oral Medicine Research Center, Fukuoka Gakuen, Fukuoka, ²Department of Oral and Maxillofacial Anatomy, Graduate School of Medical and Dental Sciences, Tokyo Medical and Dental University, Tokyo, Japan, ³Department of Neurosurgery, Tulane Center for Clinical Neurosciences, Tulane University School of Medicine, New Orleans, LA, ⁴Department of Neurology, Tulane Center for Clinical Neurosciences, Tulane University School of Medicine, New Orleans, LA, USA, ⁵Dental and Oral Medical Center, Kurume University School of Medicine, Kurume, Fukuoka, ⁶Division of Gross and Clinical Anatomy, Department of Anatomy, Kurume University School of Medicine, Kurume, Fukuoka, Japan, ⁷Department of Anatomical Sciences, St. George's University, St. George's, Grenada, West Indies, ⁸Department of Structural & Cellular Biology, Tulane University School of Medicine, New Orleans, LA, ⁹Department of Surgery, Tulane University School of Medicine, New Orleans, LA, USA, ¹⁰Department of Anatomy, Daegu Catholic University School of Medicine, Daegu, Korea

Abstract: The orbicularis oculi (OOc) is a sphincteric muscle of the eyelids, whereas contraction of the orbicularis oris (OOr), another sphincteric muscle, causes narrowing of the lips. Facial muscle fibers normally blend with adjacent muscles. However, muscle fibers connecting the various facial muscles that have different actions and that are located at distant sites, such as the OOc and the OOr have been rarely reported. Herein, we report a rare case of connecting fibers between the inferior margin of the OOc and the OOr. These connecting fibers were blended with the OOr between the inserting fibers of the levator labii superioris and levator anguli oris. Contraction of such variant muscles might affect typical facial expressions.

Key words: Orbicularis oculi, Orbicularis oris, Connecting fibers, Anatomical variations, Cadaver

Received May 26, 2022; Accepted June 16, 2022

Introduction

Between the inferior margin of the orbicularis oculi (OOc) and orbicularis oris (OOr) muscles, the zygomaticus major (Zmj), zygomaticus minor (Zmi), levator anguli oris (LAO), levator labii superioris (LLS), and levator labii superioris alaeque nasi (LLSAN) muscles are found [1]. In general, the OOr and OOc are considered independent muscles that work separately. However, variations have been reported in this area, e.g., different insertion patterns of Zmi [2, 3] and Zmj [4]. However, to our knowledge, variant muscle fibers

connecting the inferior margin of the OOc to the OOr have not been reported. Here, we report such an anatomical variation.

Case Report

During routine dissection of the face, connecting fibers between the inferior margin of the OOc and the OOr were found in a cadaver of a 56-year-old at death male (Fig. 1). The skin just lateral to the nasolabial fold was removed to reveal the connecting fibers and the adjacent facial muscles passing beneath the nasolabial fold. The remaining skin was reflected to observe the course and attachments of the connecting fibers and facial muscles (Fig. 1A). Next, the remaining skin was removed to expose the entire muscles of the face (Fig. 1B). The inferior margin of the OOc was reflected superiorly to observe the course and attachment of the connecting fibers (Fig. 1C).

At the middle of the inferior margin of the OOc, some

Corresponding author:

Mi-Sun Hur

Department of Anatomy, Daegu Catholic University School of Medicine, Daegu, Korea

E-mail: mshur@cu.ac.kr

*These authors contributed equally to this work.

Copyright © 2022. Anatomy & Cell Biology

This is an Open Access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (<http://creativecommons.org/licenses/by-nc/4.0/>) which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

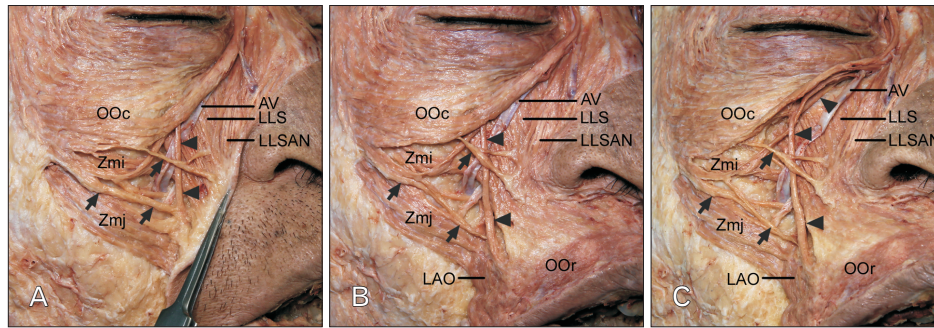


Fig. 1. Connecting fibers between the inferior margin of the OOc and OOr. (A) At the middle of the inferior margin of the OOc, the connecting fibers (arrowheads) descended perpendicularly and passed beneath the site between the middle and the lower thirds of the nasolabial fold. Adjacent to the connecting fibers, there were several fibers (arrows) from the OOc attaching along the nasolabial fold. Skin just lateral to the nasolabial fold was removed and the remaining skin was reflected to reveal the courses and attachments of the connecting fibers and the adjacent extending fibers from the OOc. (B) The connecting fibers (arrowheads) blended with the OOr between the inserting fibers of the LLS and LAO. The several fibers (arrows) from the OOc were toward the LLSAN, LLS, and Zmi. The remaining skin was removed to expose the entire muscles in the face. (C) The extending fibers of the OOc that divided the connecting fibers (arrowheads) were attached to the maxilla just above the origin site of the LLS. The inferior margin of the OOc were reflected superiorly to reveal the course and attachment of the connecting fibers. AV, angular vein; LAO, levator anguli oris; LLS, levator labii superioris; LLSAN, levator labii superioris alaeque nasi; OOc, orbicularis oculi; OOr, orbicularis oris; Zmi, zygomaticus minor; Zmj, zygomaticus major.

extending fibers of the OOc descended perpendicularly and passed beneath the site between the middle and the lower thirds of the nasolabial fold. Adjacent to the connecting fibers, there were several fibers from the OOc attaching along the nasolabial fold. These several fibers that extended from the OOc were attached to the dermis of the middle of the nasolabial fold or the site between the middle and lower thirds of the nasolabial fold. The connecting fibers coursed deep or superficial to these several fibers from the OOc and coursed superficial to the angular vein (Fig. 1A). The connecting fibers blended with the OOr between the inserting fibers of the LLS and LAO. The several fibers from the OOc were toward the LLSAN, LLS, and Zmi (Fig. 1B). The extending fibers of the OOc that divided the connecting fibers were attached to the maxilla just above the origin site of the LLS. The connecting fibers between the inferior margin of the OOc and OOr and the adjacent muscle fibers extending from the OOc were at the level of the dorsum of the nose to the level of the middle of the upper lip above the corner of the mouth (Fig. 1C). At the corresponding site of the contralateral side of the face, some of the middle inferior margin of the OOc extended to the Zmi obliquely and connecting fibers between the inferior fibers of the OOc and the OOr were not found. No other variations in the dissection field were identified. The authors state that every effort was made to follow all local and international ethical guidelines and laws that pertain to the use of human cadaveric donors in

anatomical research [5].

Discussion

The connecting fibers and their adjacent muscle fibers were attached along the nasolabial fold in the present study. The muscles of facial expression are often interdigitated with adjacent muscles [1, 6-8]. Additionally, peripheral fibers of the OOc overlie and occasionally blend with the muscles arising from the bones of the orbital rim [9].

The facial muscles responsible for producing the nasolabial fold have been discussed by several authors [4, 10-12]. Most authors have reported that the LLSAN inserted into the medial nasolabial fold, the LLS inserted into the middle third of the nasolabial fold, the Zmj inserted into the lateral nasolabial fold. Hur et al. [3] concluded that fibers extending from the OOc to the Zmi assist in deepening and elevating the nasolabial fold. In the present case, the connecting fibers passed deep to the site between the middle and lower thirds of the nasolabial fold, and their adjacent fibers that extended from the OOc were attached to the middle of the nasolabial fold or the site between the middle and lower thirds of the nasolabial fold. Contraction of the connecting fibers and adjacent muscle fibers extending from the OOc might also assist in deepening the nasolabial fold. In addition, the connecting fibers blended with the upper OOr where the LAO inserted at the corner of the mouth. Contraction of the con-

necting fibers might raise the corner of the mouth via contraction of the OOC.

The lower half of the orbital portion of the OOC raises the skin of the cheek, causing the wrinkles seen to radiate from the corner of the eye [13]. Thus, the connecting fibers and extending fibers from the OOC to the upper lip might assist in elevating the OOR. The OOC and OOR have different actions and distant sites. The OOC is a sphincteric muscle of the eyelids and plays an important role in facial expression, whereas contraction of the OOR causes narrowing of the mouth [1, 14]. The connecting fibers between the inferior margin of the OOC and OOR seen in the present case might assist in simultaneous movements of the eye and mouth.

Connecting fibers between the inferior margin of the OOC and OOR is a rare anatomical variation. Such a variant muscle of the face could possibly affect facial expression and when found unilaterally, this could result in asymmetry of facial expression.

ORCID

Norio Kitagawa: <https://orcid.org/0000-0001-5565-4210>

Joe Iwanaga: <https://orcid.org/0000-0002-8502-7952>

R. Shane Tubbs: <https://orcid.org/0000-0003-1317-1047>

Hongtae Kim: <https://orcid.org/0000-0001-6701-8481>

Yong Suk Moon: <https://orcid.org/0000-0001-5405-8919>

Mi-Sun Hur: <https://orcid.org/0000-0002-1482-1657>

Author Contributions

Conceptualization: MSH. Data acquisition: MSH. Data analysis or interpretation: NK, JI, RST, HK, YSM, MSH. Drafting of the manuscript: NK, JI, RST, HK, YSM, MSH. Critical revision of the manuscript: NK, JI, RST, HK, YSM, MSH. Approval of the final version of the manuscript: all authors.

Conflicts of Interest

No potential conflict of interest relevant to this article was reported.

Acknowledgements

The authors sincerely thank those who donated their bodies to science so that anatomical research could be per-

formed. Results from such research can potentially increase mankind's overall knowledge that can then improve patient care. Therefore, these donors and their families deserve our highest gratitude [15].

This work was supported by the National Research Foundation of Korea (NRF) grant funded by the Korea government (MSIT) (No. 2020R1C1C1003237).

References

1. Standring S. Gray's anatomy: the anatomical basis of clinical practice. 42nd ed. London: Elsevier; 2020.
2. Choi DY, Hur MS, Youn KH, Kim J, Kim HJ, Kim SS. Clinical anatomic considerations of the zygomaticus minor muscle based on the morphology and insertion pattern. *Dermatol Surg* 2014;40:858-63.
3. Hur MS, Youn KH, Kim HJ. New insight regarding the zygomaticus minor as related to cosmetic facial injections. *Clin Anat* 2018;31:974-80.
4. Hur MS, O J, Yang HM, Kwon HJ, Lee S, Lim HS, Lim SY, Oh CS. Heights and spatial relationships of the facial muscles acting on the nasolabial fold by dissection and three-dimensional microcomputed tomography. *PLoS One* 2020;15:e0237043.
5. Iwanaga J, Singh V, Takeda S, Ogeng'o J, Kim HJ, Morys J, Ravi KS, Ribatti D, Trainor PA, Sañudo JR, Apaydin N, Sharma A, Smith HF, Walocha JA, Hegazy AMS, Duparc F, Paulsen F, Del Sol M, Addis P, Louryan S, Fazan VPS, Boddetti RK, Tubbs RS. Standardized statement for the ethical use of human cadaveric tissues in anatomy research papers: recommendations from Anatomical Journal Editors-in-Chief. *Clin Anat* 2022;35:526-8.
6. Hollinshead WH. Anatomy for surgeons: Vol. 1. The head and neck. 3rd ed. New York: Harper & Row; 1982.
7. Iwanaga J, Hur MS, Kikuta S, Ibaragi S, Tubbs RS. Extended crossing fibers of the mentalis muscle attaching to the contralateral mandible. *Anat Cell Biol* 2021;54:522-4.
8. Hur MS, Lee S, Jung HS, Schneider RA. Anatomical connections among the depressor supercillii, levator labii superioris alaeque nasi, and inferior fibers of orbicularis oculi: implications for variation in human facial expressions. *PLoS One* 2022;17:e0264148.
9. Woodburne RT, Burkel WE. Essentials of human anatomy. 9th ed. New York: Oxford University Press; 1994.
10. Pessa JE, Brown F. Independent effect of various facial mimetic muscles on the nasolabial fold. *Aesthetic Plast Surg* 1992;16:167-71.
11. Snider CC, Amalfi AN, Hutchinson LE, Sommer NZ. New insights into the anatomy of the midface musculature and its implications on the nasolabial fold. *Aesthetic Plast Surg* 2017;41:1083-90.
12. Kwon HJ, O J, Cho TH, Choi YJ, Yang HM. The nasolabial fold: a micro-computed tomography study. *Plast Reconstr Surg* 2020;145:71-9.

13. Morris H. Human anatomy: a complete systematic treatise. 10th ed. Philadelphia: Blakiston; 1947.
14. Sinнатamby CS. Last's anatomy: regional and applied. 12th ed. New York: Churchill Livingstone/Elsevier; 2011.
15. Iwanaga J, Singh V, Ohtsuka A, Hwang Y, Kim HJ, Morys J, Ravi KS, Ribatti D, Trainor PA, Sañudo JR, Apaydin N, Şengül G, Albertine KH, Walocha JA, Loukas M, Duparc F, Paulsen F, Del Sol M, Adds P, Hegazy A, Tubbs RS. Acknowledging the use of human cadaveric tissues in research papers: recommendations from Anatomical Journal Editors. Clin Anat 2021;34:2-4.